Project No. 3074
File: 3074.4

AUGUST MONTHLY PROGRESS REPORT
MONTANA DOT "PERFORMANCE PREDICTION MODELS"

Monthly Progress Report To:	**Susan Sillick, MT DOT**
	Jon Watson, MT DOT
Agency:	**Fugro-BRE**
Contract No.:	**HWY-30604-DT**
Prepared By:	**Harold Von Quintus**
Date Prepared:	**September 28, 2001**

1.0 CURRENT MONTH WORK ACTIVITIES AND ACCOMPLISHMENTS

Task 1 – Literature Review

The literature review was completed. All distress prediction models being considered by and those that are being incorporated into the 2002 Design Guide under NCHRP 1-37A, as well as all of the distress prediction models that are being used in development of the NHI Course on Introduction to Mechanistic-Empirical Design were reviewed.

A draft memorandum was prepared that summarizes the models that will be considered within this project. The draft memorandum will be provided to the Department.

Task 2 – Review of MT DOT Pavement-Related Data

As a result of the July 2nd meeting, various information and data were obtained from the MT DOT for possible use in planning the experimental design and data collection activities. Specifically, information on the pavement management database, deflection testing, distress surveys, longitudinal profile testing, and construction information was obtained from the MT DOT and reviewed by the project team.

The materials and testing specifications are being reviewed. This information will be included in the experimental factorials/plan and the Materials Sampling and Testing Plan being prepared for future use by Department personnel.

Both project personnel and Dr. Hallenbeck have contacted Mr. Dan Bisom with the MT DOT to ensure that we have a correct understanding on the traffic data that has been collected and stored along the various roadways in Montana. The project team is reviewing the traffic data to develop critical issues and any necessary data.

Project personnel have obtained and extracted traffic data, materials data, climatic data, soils data, and other information from all of the a LTPP sites located in Montana. A list of missing data was provided to the Department for coordinating with LTPP to obtain this data. The project staff provided a listing of the missing data to Mr. Jon Watson in preparation for the Department's meeting with the LTPP Regional Coordination Office to determine the status of this missing data. One of the areas of concern is that there are no weighing-in-motion data in the LTPP traffic data tables. The missing traffic data were discussed with Mr. Bisom.

Task 3 – Establish the Experimental Factorials
A draft experimental factorial and testing plan was provided to the Department during the July 2nd meeting. Additional pavement types and areas within the State were identified as different. These site conditions and pavement types were identified as high priority for the experimental plan. The project team plans to coordinate with the Department to identify test sections to fill the experimental factorial. As part of the experimental factorial, all of the LTPP sites adjacent to Montana have been reviewed and information extracted from the LTPP database to determine which of those sites have similarities to Montana conditions and thereby can be included in the experimental factorial.

Task 4 – Develop Work Plan for the Monitoring and Testing Plans
A meeting was held at the Fugro-BRE offices on August 8-9 for the project staff, consultants and subcontractors to review the experimental plan and factorial. A copy of the meeting minutes was provided to the Department and is attached to this progress report.

Task 5 – Presentation of Work Plan to MT DOT
Preparation for a meeting with the technical panel to review the results completed to-date under Phase I.

Task 6 – Implement Work Plan – Data Collection
No activity.

Task 7 – Data Analyses and Calibration of Performance Prediction Models
No activity.

Task 8 – Final Report and Presentation of Results
No activity.

2.0 PROBLEMS/RECOMMENDED SOLUTIONS

No problems were encountered during last month and none are anticipated for next month.

3.0 NEXT MONTH'S WORK PLAN

The activities planned for next month are identified and discussed below.

- The experimental factorials and design will be completed and submitted to the Department near the end of September. This final experimental factorial will identify all sites to be included in the monitoring program. These include the existing LTPP sites in Montana and in adjacent States and those test sections that will be added to the program this year.

- A draft of the monitoring and testing work plan will be completed and submitted for review to the Department under Task 4.

- The presentation of the work plan to the Department will be on October 2nd.

- Project personnel will identify and select additional test sections for the experimental factorial.

4.0 FINANCIAL STATUS

Following is a summary of the estimated expenses incurred during the month of August. Accumulated expenses for the project, estimated through the end of the month are represented graphically in the attached line chart.

Cost Element	Previous Month's Cumulative Cost, $	Current Monthly Expenditures (Estimated), $	Cumulative Costs (Estimated), $
Direct Labor	3,015	4,669	7,684
Overhead	4,311	6,677	10,988
Consultants/Subcontractors	0	4,050	4,050
Travel	1,777	1,476	3,253
Testing	0	0	0
Other Direct Costs	12	25	37
Fee	911	1,690	2,601
Total Costs	10,026	18,587	28,613

The following table provides a summary of the total expenditures by the Montana and FHWA fiscal years in comparison to the allocated funds for each fiscal year.

Montana DOT Fiscal Year				FHWA Fiscal Year			
Fiscal Year		Allocated Funds Cumulative, $	Expenditures Cumulative, $	Fiscal Year		Allocated Funds Cumulative, $	Expenditures Cumulative, $
6/1-6/30	2001	15,000	0*	6/1-9/30	2001	65,000	28,613
7/1-6/30	2002	218,969	28,613	10/1-9/30	2002	258,969	---
7/1-6/30	2003	348,969	---	10/1-9/30	2003	358,969	---
7/1-6/30	2004	388,969	---	10/1-9/30	2004	398,969	---
7/1-6/30	2005	428,969	---	10/1-9/30	2005	438,969	---
7/1-6/30	2006	498,969	---	10/1-9/30	2006	498,969	---
	TOTAL	498,969	10,026			498,969	10,026

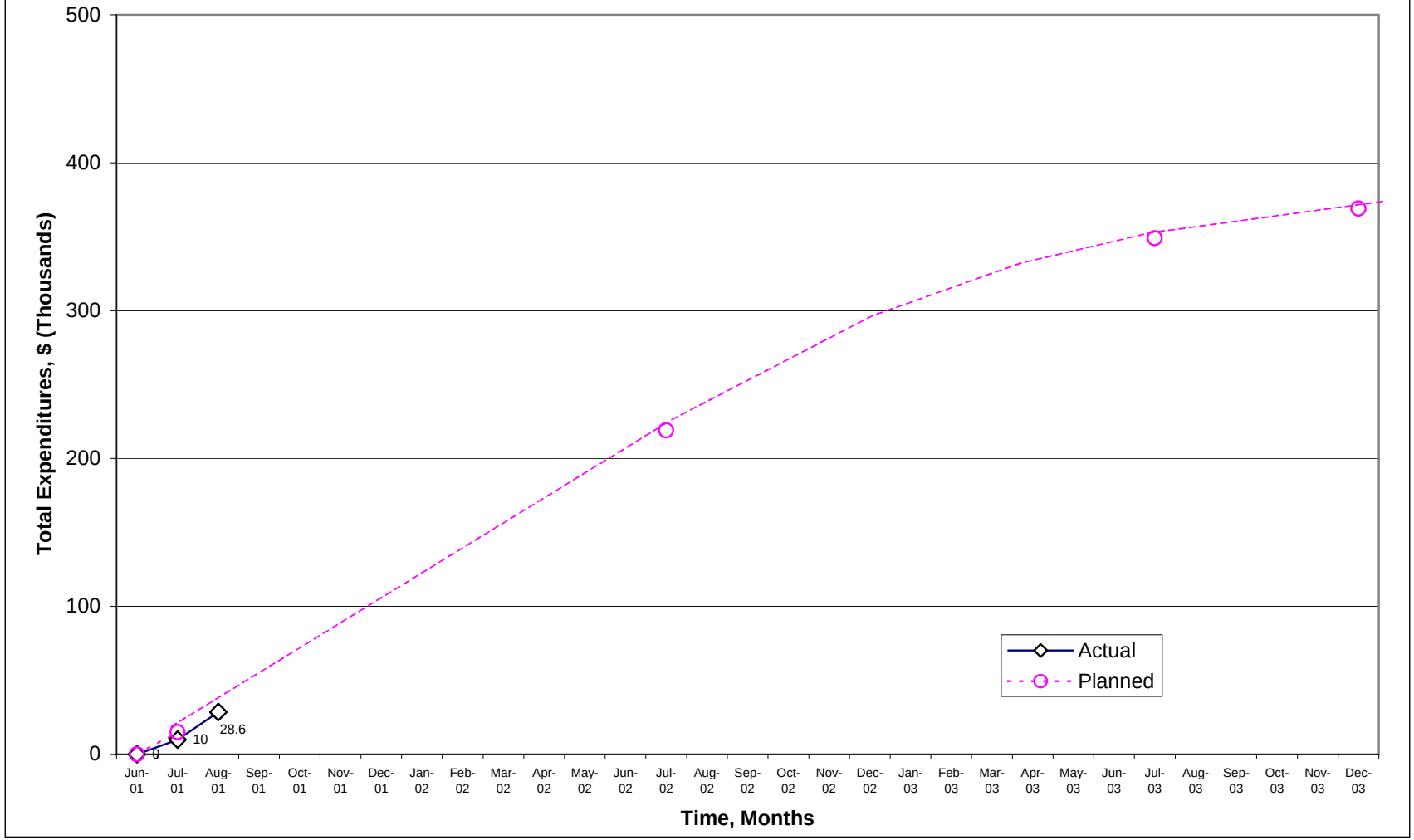
*June 2001 expenditures were combined with July 2001 expenditures.

CC: Brian Killingsworth, Fugro-BRE
Starr Kohn, SME
Dick Moore, P-B
Amy Simpson, Fugro-BRE
Weng-On Tam, Fugro-BRE

Monthly Progress Report - Financial Status

Contractor: Fugro-BRE
Montana DOT: "Performance Prediction Models"
Fugro-BRE Project No.: 3074

Contract No.: HWY-30604-DT



Project Title: "Performance Prediction Models"
Project Number: HWY-306041-DT

MEETING MINUTES

Meeting Date: 8-9 August 2001
Meeting Location: Fugro-BRE, Inc. Conference Room, Austin, Texas
Attendance:

Name	Organization	Phone Number
Amy Simpson	Fugro-BRE, Inc.	512/977-1800
Brent Rauhut	Consultant	512/345-9579
Brian Killingsworth	Fugro-BRE, Inc.	512/977-1800
Harold Von Quintus	Fugro-BRE, Inc.	512/977-1800
Mark Hallenbeck	TRAC	206/543-6261
Matthew Witczak	Consultant	480/585-2197
Weng On Tam	Fugro-BRE, Inc.	512/977-1800

Due to scheduling conflicts, Starr Kohn was unable to attend.

The following summarizes the meeting conducted with the project consultants highlighting their involvement in Tasks 1 through 6. The project team member responsible for an action item is listed at the end of that item. A copy of the agenda is attached at the end of minutes.

Handouts provided at the meeting:

1. List of data elements to be included in the MDOT study based upon 1-37A models (Harold)
2. Project overview presentation slides (Harold)
3. Chapters of the NCHRP 1-37A pavement design guide related to flexible pavement on CD (Harold)
4. Map of the LTPP sections in Montana and surrounding states/provinces (Harold)
5. Distress prediction models presentation slides (Weng On)
6. Selection of Montana Distress Prediction Models – Draft literature review (Weng On)
7. Database tables and structure (Amy)
8. LTPP test section designations and monitoring information for MDOT and surrounding states test sections (Amy)
9. Missing data spreadsheet (Amy)
10. Traffic data collection and analysis presentation slides (Weng On)
11. Normalized truck class distribution plots for Montana (Weng On)
12. Performance monitoring and laboratory testing presentation slides (Brian)
13. Histograms of rutting, fatigue cracking, longitudinal cracking and transverse cracking for Montana LTPP test sections (Amy)
14. Alternate IRI models based upon LTPP GPS-1 test sections (Starr via Harold)
15. Distribution of RMSE and Modulus for all LTPP test section layers and deflection basins in Montana (Amy)
16. TRR 1377 paper for Layer Moduli from Deflection Measurements for SHRP (Weng On)

The meeting began with an overview of the project provided by Harold. Highlights from this discussion are as follows:

1. It is permissible for members of the project team to contact MDOT employees on an as-needed basis. However, any correspondence (including e-mail) should be copied to Jon Watson and Susan Sillick at MDOT (see addresses and e-mail below).

   Mr. Jon Watson
   Research, Development and Technology Transfer Program
   Research Management Unit
   Materials Bureau
   2701 Prospect Avenue
   P.O. Box 201001
   (406) 444-7260 phone
   (406) 444-6204 fax
   jwatson@state.mt.us

   Ms. Susan C. Sillick
   Research, Development and Technology Transfer Program
   Research Management Unit
   Materials Bureau
   2701 Prospect Avenue
   P.O. Box 201001
   Helena, MT 59620-1001
   (406) 444-7693 phone
   (406) 444-6204 fax
   ssillick@state.mt.us

   In addition, pertinent members of the project team should be copied, in particularly Harold, so that all appropriate parties are informed of a specific request or contact with MDOT.

2. The point was made that the NCHRP 1-37A software is a comprehensive and complex program. Modifying the code, specifically the portion containing the models, will not be possible under the current contract with MDOT. In other words, replacing the models contained in the software with different models will not be possible under the current scope of work and funds.

3. The project team will investigate the possibility of using the NCHRP 1-37A models in a simplified form to support the current MDOT pavement management system. If these models are unsuitable, alternate models that are similar in nature to the 1-37A models may be recommended to support the PMS.

4. The schedule is aggressive during the first few months of the project due to the time of project award and the upcoming winter season. Therefore, all initial activities are on an accelerated schedule. One area of possible delay is the materials testing that must be completed on the LTPP and additional project sections prior to the initial calibration analysis. If for some reason the material testing is not completed before the start of the initial calibration, the project team

will make use of the data that currently exists and supplement missing data where appropriate.

5. The issue of determining what percentage of rutting is due to actual material permanent deformation versus wear from studded tires is vitally important to the rutting calibration. It was pointed out that the best (and probably the only) way to settle this issue is to dig trenches at the calibration sections and physically measure the permanent deformation in each pavement layer. In addition, close inspection of the wearing surface from the trench may also provide a better understanding of the mechanisms involved in the development of rutting. The project team will pursue a brief review of Scandinavian literature and contact a couple of key individuals regarding this topic. (Harold/Amy)

6. It was suggested to move the pavement sections incorporating pulverization from the new construction category to the rehabilitation category for calibration. This will better match the definitions used in the NCHRP 1-37A pavement design guide.

7. Currently the east and west demarcation line for the state is based upon temperature, moisture and geology. It was suggested to make this demarcation based upon the Rockies in the West and the Great Plains in the East. In addition, the east could be divided into subzones based on temperature and moisture if deemed appropriate.

8. Sites from the CRREL seasonal study can possibly be used for the calibration analysis. The project team will contact Vince Janoo to obtain information about these sites. (Harold)

9. The NCHRP 1-37A deliverables (software, reports, etc.) should be completed and turned-in by June 2002. Our team should plan on making a presentation of the software to MDOT in the near future. This should help MDOT personnel better understand the 1-37A design process and provide a “visual” feel for the software.

10. To provide a better database for Montana climatic conditions, it is recommended that MDOT modify the 1-37A software environmental database to only include information for Montana and its surrounding regions and include additional years of environmental data (up to 20 years). The project team needs to identify the location of each of the Montana weather stations for use in the development of the calibration experimental plan. (Amy, Weng On)

11. A group of northeast state DOT representatives will be visiting ASU for a materials testing workshop during August 22-24, 2001. The project team needs to extend an invitation to MDOT to attend this meeting. (Harold)

12. MDOT will be conducting a comparison of the state operated profiler and FWD to the WRCO equipment. It was recommended that the state first check the repeatability of their equipment by following the procedures in ASTM E950 before doing any equipment comparisons, if they have not already done so.

13. Currently, the frost heave portion of the EICM is not implemented in the NCHRP 1-37A software. The project team may want to recommend to MDOT that this portion of the EICM be utilized for their design system due to the nature of their soils and environmental conditions. This should be discussed further with the pertinent personnel from MDOT. (Harold/Matt)

The next portion of the meeting consisted of a review of the NCHRP 1-37A models as well as some other pavement distress prediction models identified in the literature by Weng On.

14. The project team will ensure that the most current 1-37A models are used and discussed within the project team and with MDOT.

Amy then discussed the database structure and pertinent data elements. Feedback was provided by the team regarding any changes that need to be made to the draft data tables. The following provides a list of action items that needs to be completed for the database.

15. A table needs to be added to the database regarding environmental data. A copy of the NCHRP 1-37A environmental database needs to be obtained from ASU. (Amy)

16. The traffic portion of the database needs to include truck volumes as well as the axle load distributions. (Amy)

17. The project team will need to create a master dataset of default values. (Amy)

18. It was agreed that the additional pavement sections that will be included in the calibration analysis should have identification numbers assigned. It was further recommended that these numbers should correspond in some way to the MDOT PMS database. Therefore, Fugro-BRE, Inc. needs to contact Dick Moore regarding the PMS document that was obtained from Montana DOT and determine their identification scheme. (Amy)

19. A feedback form for the Montana traffic data in the database should be submitted to LTPP because all of the values are currently zeros. (Amy)

20. A request for the level 3 traffic data from the CTDB should be made. This letter should come from MDOT, however the project team will develop the letter and send to Jon Watson for his signature. (Amy)

21. The schema created for the two testing tables should be for the raw data only. (Amy)

22. In the unbound table, the following changes should be made: (Amy)

    a. include the % passing the #4, #40, #80, and #100 sieves;
    b. change % retained to % passing;
    c. include resilient modulus values for all of the stress states conducted for LTPP and provide placeholders for additional stress states;

d. include the moisture and density values at which the resilient modulus testing was completed;
e. for the maximum density, include a place to put the compactive effort;
f. check the environmental chapter of the 2002 guide to determine the need for any additional data elements.

23. In the HMA table, the following changes should be made: (Amy)

a. change % retained to % passing;
b. include % passing the #4 sieve;
c. for resilient modulus, include the temperature at which the test was run, the time of loading, and the time of unloading;
d. include the age of the sample for each test;
e. make three separate tables – one for lab design, one for in situ materials (at whatever age), and one for in situ materials at the time of construction;
f. include the indirect tensile strength for 0°C, -4°C, and -10°C;
g. include the Poisson's Ratio, complex modulus, creep compliance;
h. in the processed table, include the effective asphalt content;
i. separate the binder information from the mix information and add additional penetration and temp tests and Brookfield viscosity.

24. The layer structure table should include the depth to bedrock and the depth to ground water table. (Amy)

25. Indicate in the rut depth table that all measurements from the MDOT PMS are based on a lane-width string line. Also include a placeholder for rutting measurements derived from trenching. (Amy)

26. The current profile table needs to include run number and a second table needs to contain the average IRI, standard deviation, etc. (i.e. processed data). (Amy)

27. The project team members associated with traffic data collection and analysis should review all traffic data tables. This includes Mark Hallenbeck and Weng On Tam.

28. The distress table needs to include thermal cracking, fatigue cracking, average rut depth for the section, standard deviation of rut depth, studded tire wear, and an indication of whether cracking is top-down or bottom-up. (Amy)

29. In the section-level backcalculation table, section uniformity (as determined by the procedures described in FHWA Report RD-97-076) and sub-sectioning limits should be included. (Amy)

30. In the point-level backcalculation table, the program used to do the backcalculation, the layer type, and a flag indicating assumed layer thickness should be included. (Amy)

31. In the deflection data, deflection hardening or deflection softening as determined by the procedures described in FHWA Report RD-97-076 should be indicated. (Amy)

32. In the general section table, rather than just the construction date, the date of earthwork compaction (for the EICM), the date the asphalt placement (aging model) and the date open to traffic (damage function begins) should be included. These dates are used by the NCHRP 1-37A pavement response model. In the database documentation, an explanation regarding why these dates were used instead of the construction date should be included. (Amy)

After a review of the data tables, Amy then led a discussion regarding the missing data elements from the LTPP sections for Montana and surrounding states. An Excel spreadsheet has been developed for each LTPP pavement section denoting missing data for the following:

- Gradation
- Resilient Modulus
- Optimum Moisture
- Maximum Density
- CBR
- R-value
- Atterberg Limits
- AASHTO Soil Class
- Asphalt Content
- Bulk Specific Gravity
- Maximum Specific Gravity
- Binder Specific Gravity
- Ring & Ball Softening Point
- Pen 77
- Pen 39
- Visc 140
- Visc 275
- Aggregate Bulk Specific Gravity
- VMA
- AC Grade

Weng On completed a review and discussion of the traffic data focusing on the collection and analysis of the existing data from the sites in Montana. There was also discussion about the additional WIM and volume count sites that are planned by MDOT. This discussion focused on how these sections would support the additional calibration pavement sections that are currently being selected. Some of the highlights of this discussion are noted below:

33. There is good coverage of WIM/AVC sites throughout the state with the exception of the northeast portion of the state. The project team needs to discuss with MDOT the expected traffic volumes in this part of the state and determine if the volumes are significant enough to warrant additional traffic data collection sites. (Mark)

34. For the NCHRP 1-37A design software, hourly traffic data for flexible pavements is not required. Only the concrete analysis utilizes hourly traffic data for the pavement response model to incorporate temperature gradient effects (warping and curling) on stress development.

35. Currently the LTPP SPS-1 and SPS-9 sections do not have corresponding traffic data in the LTPP IMS. However, it was pointed out the MDOT has traffic collection sites near these test sections. Therefore, the project team will need to request this data so that traffic information can be assigned to these sites. (Mark/Weng On)

36. The project team has several questions and will Dan Bisom regarding these traffic-related issues. (Mark)

37. The project team would also like to get ALL traffic data from Montana DOT and review it for use on the project.

38. Site-specific traffic output files need to be generated by November 2001 so that they may be used in the initial calibration. (Weng On)

Brian then led a discussion on the field data collection, laboratory testing and performance monitoring plans. Some of the highlights of this discussion are listed as follows:

39. For performance monitoring, the project team will establish an initial site visit schedule for each calibration test section over the 5-year contract and beyond. However, this schedule may change as a section begins to develop distress (especially on newer pavement sections) so that multiple data points are collected along the distress development curve. This portion of the curve tends to be steeper as distress develops more rapidly and then levels out over time. (Brian)

40. Replicate sections will not be utilized in the study. This decision is based upon the fact that there will be an increase in expense in data collection without significant benefit to calibration exercise. In addition, it was agreed that funds should be focused on getting and maintaining the additional calibration sites to supplement the LTPP data.

41. Data that is missing from the LTPP test sections is important to the calibration effort. MDOT is taking steps to obtain this data in conjunction with the LTPP WRCO. The project team would need to have this data during contract year 3 for complete calibration to be possible.

42. For low temperature indirect tensile creep and strength testing the project team can use 6” diameter specimens (cores) and will recommend utilizing Rey Roque’s revised test method for testing.

43. When sampling materials for testing, it is strongly recommended that trenches be dug to recover materials and so that individual pavement layer rutting may be measured. In the absence of trenches the project team may be able to utilize test pits and/or cores and borings. (Dick/Brian)

44. During field data collection, cores will need to be taken on top of longitudinal cracks to verify the place of initiation and from areas where there is no cracking. (Brian)

45. When testing unbound materials for resilient modulus, the in-situ moisture conditions will be utilized to compact the specimens.

46. The team will also consider a brief review of the literature to identify established correlations of R-value to Mr. This decision will be discussed with MDOT to assess the value of this exercise and to see if this has already been completed by MDOT at some point in time. (Brian)

47. The project team will need to discuss the characterization of the pulverized pavement layers (specifically those stabilized with PCC) with MDOT. The experience of MDOT with these layers will be beneficial to the team in determining the most appropriate method for characterizing these layers for calibration. It is envisioned that the backcalculated Mr could be used as well as characterization through unconfined compressive strength, if the layers are at least semi-rigid. (Harold/Matt)

48. Bulk HMA material will be required if the experimental plan includes dynamic modulus testing (i.e. in support of the NCHRP 1-37A design process). Currently, bulk HMA material is only possibly available for the LTPP SPS-1, 5 and 9 sections and is expected to be available for the additional sections selected that are newly constructed during this project.

49. The project team will need to discuss the most appropriate method for permanently marking the calibration pavement sections. Methods can include a sign (similar to the LTPP signs) or some other stake or pole in the ROW. In addition, a simple marker placed into the HMA pavement shoulder could also be used. It is recommended that the state determine this method based upon their current regulations and procedures. (Dick/Brian)

50. If trenching is used to collect materials, it is imperative that saws be used to cut through bound layers. This will maintain a smooth face from which rutting measurements may be made.

51. To be able to utilize the complex modulus prediction equation, conventional binder testing will be required. This will be added to the material sampling and testing plan after the final experimental plan has been completed. (Brian)

The following notes some of the important points that must be considered when selecting additional calibration pavement sections and are based upon discussions conducted throughout the meeting.

52. During field marking of the sections, avoid areas where irrigation at or near the pavement may impact performance (in addition to the other items noted in the performance monitoring and testing plan discussion by Brian).

53. If possible, the project team should consider having FWD measurements taken on a site that has been selected before making the final selection of the 500-ft test section. This could help avoid selecting a section that has areas that may perform very differently.

54. When selecting sites, the team also needs to ensure that the sites have traffic collection sites nearby or can have equipment installed (e.g. make sure electricity is nearby).

55. Currently the team is considering sites in the following general areas:

    a. Between Glasgow and Wolf Pont
    b. Northwest o Missoula
    c. North of Conrad
    d. East of Broadus
    e. Near Glendive
    f. Near Yellowstone
    g. Between Billing and Roundup
    h. South of Lewistown
    i. Between Lewistown and Sydney
    j. South of Dillon